Claims

1. A method for performing the operations for synchronizing a receiver (1) with a received code-modulated spread spectrum signal, in which method at least one reference code (r(x)) is used, which reference code corresponds to a code used in the modulation, the frequency shift of the received signal and the code phase of the code used in the modulation are acquired, **characterized** in that the method includes at least the following steps:

- sample vector formation step, in which samples (101) are taken from the received signal for forming the sample vectors (p(1), p(2)...p(N)),
- correlation step (102, 103, 104, 105), in which a first Hartley transform ($\overline{\mathrm{R}}(x)$) is formed on the basis of said reference code (r(x)), and a second Hartley transform (P(i)) is formed on the basis of each sample vector (p(1), p(2)...p(N)), a multiplication is performed between the first Hartley transform ($\overline{\mathrm{R}}(x)$) formed on the basis of said reference code and the second Hartley transform (P(i)) formed on the basis of each sample vector (p(1), p(2)...p(N)), an inverse Hartley transform is performed on each multiplication result ($M_x(i)$), and
- acquisition step (110), in which the frequency shift and code phase are acquired on the basis of the inverse Hartley transforms ($m_x(i)$) of the multiplication results ($M_x(i)$).

2. A method according to Claim 1, **characterized** in that in the method the frequency range to be examined is specified, the specified frequency range is divided into two or more parts, whereupon said sample vector formation step and correlation step are performed on each part, and that the method also comprises an analysis step, in which values of the inverse Hartley transforms ($m_x(i)$) of the multiplication results ($M_x(i)$) are saved for forming a coherent search matrix (A_x), the acquisition step is performed after the examination of the specified frequency range, and the frequency shift and code phase are acquired on the basis of the highest value of the coherent search matrix (A_x).

3. A method according to Claim 2, **characterized** in that a threshold value is specified in the method, and that quantity values of the elements $(a_x(i,j))$ of the coherent search matrix (A_x) that exceed said threshold value are used in the acquisition step for acquiring the frequency shift and code phase.

4. A method according to Claim 2 or 3, **characterized** in that in the method said sample vector formation step, correlation step and analysis step are repeated (108) for forming at least two coherent search matrixes (A_x), and that a summing step (109) is also performed in the method, in which summing step an incoherent search matrix (S_x) is formed by summing incoherently the values $(a_x(i,j))$ of the equivalent elements of the coherent search matrix (A_x) formed at each time of repetition, and that said incoherent search matrix (S_x) is used in said acquisition step for acquiring the frequency shift and code phase.

5. A method according to Claim 4, **characterized** in that in the method the frequency range to be examined is specified, the specified frequency range is divided into two or more parts, whereupon said sample vector formation step, correlation step, analysis step and summing step are performed on each part, and values of the elements of the incoherent search matrix (S_x) are saved, and that the acquisition step is performed after the examination of the specified frequency range, and the frequency shift and code phase are acquired on the basis of the highest value.

6. A method according to Claim 4 or 5, **characterized** in that a threshold value is determined in the method, and that quantity values of the elements of the incoherent search matrix (S_x) that exceed said threshold value are used in the acquisition step for acquiring the frequency shift and code phase.

7. A method according to any one of the claims 1 to 6, **characterized** in that an inverse code $(\bar{r}(x))$ corresponding to said reference code (r(x)) is used in the correlation step to form the first Hartley transform $(\overline{R}(x))$.

8. A method according to any one of the claims 1 to 6, **characterized** in that an inverse code corresponding to each sample vector (p(1), p(2)...p(N)) is used in the correlation step to form the second Hartley transform ($\overline{P}(i)$).

9. A positioning system, which comprises at least a receiver (1), synchronization means (6) for performing synchronization operations to a received code-modulated spread spectrum signal, means (16) for using at least one reference code (r(x)) in connection with the synchronization, which reference code (r(x)) corresponds to a code used in the modulation, and means (15) for acquiring the frequency shift of the received signal and the code phase of the code used in the modulation, **characterized** in that the synchronization means comprise at least:

- sample vector formation means (12, 16) for forming sample vectors (p(1), p(2)...p(N)) from the received signal,
- correlation means (6, FHT1, FHT2...FHTN) for forming a first Hartley transform ($\overline{R}(x)$) on the basis of said reference code (r(x)), and for forming a second Hartley transform (P(i)) on the basis of each sample vector (p(1), p(2)...p(N)), means for performing a multiplication between the first Hartley transform ($\overline{R}(x)$) formed on the basis of said reference code and the second Hartley transform (P(i)) formed on the basis of each sample vector (p(1), p(2)...p(N)), and means for performing an inverse Hartley transform on each multiplication result ($M_x(i)$) for forming a correlation function matrix (C_x),
- acquisition means (7, 17) for acquiring the frequency shift and code phase by using the values of the inverse Hartley transforms ($m_x(i)$) of the multiplication results ($M_x(i)$).

10. A positioning system according to Claim 9, **characterized** in that the received signals are signals transmitted by satellites of the GPS system.

11. A positioning system according to Claim 9 or 10, which comprises a data transfer network, **characterized** in that at least part of the synchronization means (6) are formed in connection with the data transfer network, and that a data transfer connection is arranged to be established between the data transfer network and the receiver (1).

12. A positioning system according to Claim 11, **characterized** in that the data transfer network comprises at least a mobile communication network.

13. A positioning system according to Claim 9 or 10, **characterized** in that the synchronization means (6) are formed in the receiver (1).

14. A receiver (1), which comprises at least synchronization means (6) for performing synchronization operations to a received code-modulated spread spectrum signal, said receiver (1) has means (16) for using at least one reference code (r(x)) in connection with the synchronization, the reference code (r(x)) corresponding to a code used in the modulation, and means (15) for acquiring the frequency shift of the received signal and the code phase of the code used in the modulation, **characterized** in that the synchronization means comprise at least:

– sample vector formation means (12, 16) for forming sample vectors (p(1), p(2)...p(N)) from the received signal,
– correlation means (6, FHT1, FHT2...FHTN) for forming a first Hartley transform ($\overline{R}(x)$) on the basis of said reference code (r(x)), and for forming a second Hartley transform (P(i)) on the basis of each sample vector (p(1), p(2)...p(N)), means for performing a multiplication between the first Hartley transform ($\overline{R}(x)$) formed on the basis of said reference code and the second Hartley transform (P(i)) formed on the basis of each sample vector (p(1), p(2)...p(N)), and means for performing an inverse Hartley transform on each multiplication result ($M_x(i)$) for forming a correlation function matrix (C_x),
– acquisition means (7, 17) for acquiring the frequency shift and code phase by using the values of the inverse Hartley transforms ($m_x(i)$) of the multiplication results ($M_x(i)$).

15. A receiver (1) according to Claim 14, **characterized** in that it also comprises at least

- means (17) for specifying the frequency range to be examined, means (5, 8, 9) for dividing the specified frequency range into two or more parts, whereupon the formation of the sample vectors and the formation of the correlation function matrix (C_x) are arranged to be performed for each part,
- means for forming a coherent search matrix (A_x),
- means (16) for saving the values of the elements ($a_x(i,j)$) of the coherent search matrix (A_x), and
- means (15) for determining the frequency shift and code phase on the basis of the highest value of the coherent search matrix (A_x).

16. A receiver (1) according to Claim 14 or 15,. **characterized** in that it comprises means (15) for specifying the threshold value, and means (15) for comparing the values of said threshold value and the values of said coherent search matrix (A_x) for determining the frequency shift and code phase.

17. A receiver (1) according to any one of the Claims 14, 15 or 16, **characterized** in that said formation of sample vectors, formation of a correlation function matrix (C_x) and formation of a coherent search matrix (A_x) are arranged to be repeated at least two times for forming a coherent search matrix ($A_{x,k}$), and that the receiver (1) also comprises summing means for forming an incoherent search matrix (S_x) by summing the values ($a_{x,k}(i,j)$) of the equivalent elements of the coherent search matrix (A_x) formed at each time of repetition, and that said incoherent search matrix (S_x) is used in the acquisition step for determining the frequency shift and code phase.

18. A receiver (1) according to Claim 14, **characterized** in that it also comprises at least

- means (17) for specifying the frequency range to be examined,
- means (5, 8, 9) for dividing the specified frequency range into two or more parts, whereupon the formation of the sample vectors and the formation of the correlation function matrix (C_x) are arranged to be performed for each part,

- means for forming a coherent search matrix (A_x),
- means for summing the coherent search matrix (A_x) to the incoherent search matrix (S_x),
- means (16) for saving the values of the elements of the incoherent search matrix (S_x), and
- means (15) for determining the frequency shift and code phase on the basis of the highest value.

19. A receiver (1) according to Claim 18, **characterized** in that it comprises means (15) for specifying the threshold value, and means (15) for comparing the values of said threshold value and the values of said incoherent search matrix (S_x) for determining the frequency shift and code phase.

20. A receiver (1) according to any one of the claims 14 to 19, **characterized** in that the correlation means comprise means (16) for forming a Hartley transform ($\overline{R}(x)$) of the inverse code ($\overline{r}(x)$) corresponding to said reference code (r(x)).

21. A receiver (1) according to any one of the claims 14 to 19, **characterized** in that the correlation means comprise means (16) for forming a Hartley transform ($\overline{P}(i)$) of the inverse code corresponding to each sample vector (p(1), p(2)...p(N)).

22. An electronic device (24), which comprises at least a location determination receiver (1), synchronization means (6) for performing synchronization operations of the location determination receiver (1) to a transmitted code-modulated spread spectrum signal, and in which the location determination receiver (1) includes means (16) for using at least one reference code (r(x)) in connection with the synchronization, the reference code (r(x)) corresponds to a code used in the modulation, and the electronic device comprises means (15) for determining the frequency shift of the transmitted signal and the code phase of the code used in the modulation, **characterized** in that the synchronization means comprise at least:

- sample vector formation means (12, 16) for forming sample vectors (p(1), p(2)...p(N)) from the received signal,

– correlation means (6, FHT1, FHT2...FHTN) for forming a first Hartley transform ($\overline{R}(x)$) on the basis of said reference code (r(x)), and for forming a second Hartley transform (P(i)) on the basis of each sample vector (p(1), p(2)...p(N)), means for performing a multiplication between the first Hartley transform ($\overline{R}(x)$) formed on the basis of said reference code and the second Hartley transform (P(i)) formed on the basis of each sample vector (p(1), p(2)...p(N)), and means for performing an inverse Hartley transform on each multiplication result ($M_x(i)$) for forming a correlation function matrix (C_x), and

– acquisition means (7, 17) for acquiring the frequency shift and code phase by using the values of the inverse Hartley transforms ($m_x(i)$) of the multiplication results ($M_x(i)$).

23. An electronic device (24) according to Claim 22, which comprises means (14, 15, 17) for determining the location of the electronic device (24) and means (18) for saving the location information, **characterized** in that the electronic device (24) also comprises means (17) for specifying the frequency range to be examined, and means (17, 22, 23) for selecting the starting frequency from said frequency range on the basis of the location information saved in the receiver (1).

24. An electronic device (24) according to Claim 22 or 23, **characterized** in that the correlation means comprise means (16) for forming a Hartley transform ($\overline{R}(x)$) of the inverse code ($\overline{r}(x)$) corresponding to said reference code (r(x)).

25. An electronic device (24) according to Claim 22 or 23, **characterized** in that the correlation means comprise means (16) for forming a Hartley transform ($\overline{P}(i)$) of the inverse code corresponding to each sample vector (p(1), p(2)...p(N)).

26. An electronic device (24) according to any one of the Claims 22 to 25, **characterized** in that it also comprises means for performing data transfer operations.

27. An electronic device (24) according to Claim 26, **characterized** in that it comprises means (22, 23) for establishing a data transfer

connection to a data transfer network, whereby the means for determining the location of the electronic device (24) comprise means (22, 23) for transmitting information needed in the location determination to the data transfer network, and means (22, 23) for retrieving information used in the location determination from the data transfer network, whereby at least part of the location determination operations are arranged to be performed in the data transfer network.

28. An electronic device (24) according to Claim 26 or 27, **characterized** in that the means for performing data transfer operations comprise at least means for performing mobile station operations.

29. An electronic device (24), which comprises at least a receiver (1) and which electronic device (24) is intended for use in connection with a positioning system, which comprises at least synchronization means (6) for performing synchronization operations of the receiver (1) to a transmitted code-modulated spread spectrum signal, means (16) for using at least one reference code (r(x)) in connection with the synchronization, the reference code (r(x)) corresponding to a code used in the modulation, means (15) for determining the frequency shift of the transmitted signal and the code phase of the code used in the modulation, and a data transfer network, **characterized** in that the electronic device (24) also comprises at least sample vector formation means (12, 16) for forming sample vectors (p(1), p(2)...p(N)) from the received signal, and transmission means (22, 23) for transmitting the sample vectors (p(1), p(2)...p(N)) and time information to the data transfer network, and that the positioning system also comprises at least

- correlation means (6, FHT1, FHT2...FHTN) for forming a first Hartley transform ($\overline{R}(x)$) on the basis of said reference code (r(x)), and for forming a second Hartley transform (P(i)) on the basis of each sample vector (p(1), p(2)...p(N)), means for performing a multiplication between the first Hartley transform ($\overline{R}(x)$) formed on the basis of said reference code and the second Hartley transform (P(i)) formed on the basis of each sample vector (p(1), p(2)...p(N)), and means for performing an inverse Hartley transform on each multiplication result ($M_x(i)$) for forming a correlation function matrix (C_x), and

- acquisition means (7, 17) for acquiring the frequency shift and code phase by using the values of the inverse Hartley transforms ($m_x(i)$) of the multiplication results ($M_x(i)$).

30. An electronic device (24) according to Claim 29, **characterized** in that it also comprises reception means (23, 22) for receiving information about the acquired frequency shift and code phase from the data transfer network.

31. An electronic device (24) according to Claim 29 or 30, which is intended for use in connection with a positioning system, and which also comprises at least means (26) for determining the location of an electronic device, **characterized** in that the electronic device (24) also comprises means (22, 23) for receiving location information from the data transfer network.

32. An electronic device (24) according to Claim 29, 30 or 31, **characterized** in that the means for performing data transfer operations comprise at least means for performing mobile station operations.